Claims

[1] An electro-magnetic force driving actuator comprising:
a hollow inner case made of magnetic material;
an outer case made of magnetic material and being concentric with the inner case and radially mounted at an interval outwardly from the inner case;
inner and outer permanent magnets abutting on an outer surface of the inner case and an inner surface of the outer case, respectively and positioned to maintain a predetermined gap between the magnets;
a coil mounted to be linearly movable in an axial direction between the inner and outer permanent magnets; and
a non-magnetic movable member having an end to which the coil is provided and linearly moving in the axial direction between the inner and outer permanent magnets with electromagnetic repulsive forces occurring due to magnetic fields by the inner and outer permanent magnets and a current density of the coil when current is supplied to the coil.

[2] The actuator as claimed in claim 1, wherein the non-magnetic movable member comprises:
a movable ring having an end to which the coil is provided and being mounted to be linearly movable in the axial direction between the inner and outer permanent magnets; and
a movable shaft mounted to be linearly movable in the inner case and linearly moving in the axial direction by the movable ring due to an end thereof connected to the movable ring.

[3] The actuator as claimed in claim 1, wherein the inner and outer permanent magnets consist of a superconducting magnet.

[4] The actuator as claimed in claim 1, further comprising first and second end plates made of magnetic material and blocking both ends of the inner and outer cases to induce a smooth flow of the magnetic fields.

[5] A circuit breaker comprising:
a hollow inner case made of magnetic material;
an outer case made of magnetic material and being concentric with the inner case and radially mounted at an interval outwardly from the inner case;
inner and outer permanent magnets abutting on an outer surface of the inner case and an inner surface of the outer case, respectively and positioned to maintain a predetermined gap between the magnets;
a coil mounted to be linearly movable in an axial direction between the inner and outer permanent magnets;

a non-magnetic movable member having an end to which the coil is provided and linearly moving in the axial direction between the inner and outer permanent magnets with electromagnetic repulsive forces occurring due to magnetic fields by the inner and outer permanent magnets and a current density of the coil when current is supplied to the coil; and

an insulation-actuating rod connected to another end of the movable member and linearly moving by the movable member to perform closing and opening operations.

[6] The circuit breaker as claimed in claim 5, wherein the inner and outer permanent magnets consist of a superconducting magnet.

[7] The circuit breaker as claimed in claim 5, wherein the non-magnetic movable member comprises:

a movable ring having an end to which the coil is provided and being mounted to be linearly movable in the axial direction between the inner and outer permanent magnets; and

a movable shaft mounted to be linearly movable in the inner case, having an end connected to the movable ring and another end connected to the insulation-actuating rod and linearly moving in the axial direction by the movable ring to move the insulation-actuating rod.

[8] The circuit breaker as claimed in claim 5, further comprising first and second end plates made of magnetic material and blocking both ends of the inner and outer cases to induce a smooth flow of the magnetic fields.

[9] The circuit breaker as claimed in claim 5, further comprising a buffering means mounted adjacent to a region that is at an end of the opening movement of the movable member and absorbing a shock force.

[10] The circuit breaker as claimed in claim 9, wherein the buffering means consists of a compressible coil spring.

[11] An electro-magnetic force driving actuator comprising:

a body made of magnetic material and having a circular chamber formed therein;

circular inner and outer permanent magnets concentrically mounted to maintain a radial interval in the chamber of the body; and

a movable member having a circular coil, mounted to be linearly movable in an axial direction between the inner and outer permanent magnets and linearly moving in the axial direction between the inner and outer permanent magnets with electromagnetic repulsive forces occurring due to magnetic fields by the inner and outer permanent magnets and a current density of the coil when current is supplied to the coil.

[12] The actuator as claimed in claim 11, wherein both ends of the inner and outer

permanent magnets are provided with first circular inner and outer supplementary permanent magnets and second circular inner and outer supplementary permanent magnets, respectively, and the movable member is integrated with the coil by positioning first and second circular magnetic rings to both ends of the coil, respectively.

[13] The actuator as claimed in claim 12, wherein polarities of the first inner and outer supplementary permanent magnets and the second inner and outer supplementary permanent magnets are opposite to those of the inner and outer permanent magnets.

[14] The actuator according to claim 12 or 13, wherein the inner and outer permanent magnets consist of a superconducting magnet.

[15] The actuator as claimed in claim 12, wherein the coil and the first and second magnetic rings are embedded in an insulating housing to be integrated with it.

[16] The actuator as claimed in claim 15, wherein the insulating housing is made of plastic material.

[17] The actuator as claimed in claim 11, wherein both ends of the movable member are provided with first and second buffering means in order to prevent the ends of the movable member from colliding with the body at the end of the axial movement of the movable member.

[18] The actuator as claimed in claim 17, wherein the first and second buffering means consist of a compressible coil spring.

[19] The actuator as claimed in claim 17, wherein the first and second buffering means consist of a compressible coil spring and are positioned between the inner and outer permanent magnets.

[20] The actuator as claimed in claim 11, wherein a plurality of non-magnetic rods are connected to an end of the movable member and a supporting member is mounted to ends of the non-magnetic rods for connecting to a driven part.

[21] A circuit breaker comprising:

a body made of magnetic material and having a circular chamber formed therein;

circular inner and outer permanent magnets concentrically mounted to maintain a radial interval in the chamber of the body; and

a movable member having a circular coil, mounted to be linearly movable in an axial direction between the inner and outer permanent magnets and linearly moving in the axial direction between the inner and outer permanent magnets with electromagnetic repulsive forces occurring due to magnetic fields by the inner and outer permanent magnets and a current density of the coil when current is supplied to the coil; and

an insulation-actuating rod connected to the movable member in order to linearly

move by the movable member of the actuator and thus to perform opening and closing operations.

[22] The circuit breaker as claimed in claim 21, wherein both ends of the inner and outer permanent magnets are provided with first circular inner and outer supplementary permanent magnets and second circular inner and outer supplementary permanent magnets, respectively, and the movable member is integrated with the coil by positioning first and second circular magnetic rings to both ends of the coil, respectively.

[23] The circuit breaker as claimed in claim 22, wherein the inner and outer permanent magnets consist of a superconducting magnet.

[24] An electro-magnetic force driving actuator comprising:
a plurality of electro-magnetic force driving actuating parts mounted in a body made of magnetic material, each of the actuating parts including:
circular inner and outer permanent magnets concentrically mounted to maintain a radial interval between the magnets;
a movable member having a circular coil, mounted to be linearly movable in an axial direction between the inner and outer permanent magnets and linearly moving in the axial direction between the inner and outer permanent magnets with electromagnetic repulsive forces occurring due to magnetic fields by the inner and outer permanent magnets and a current density of the coil when current is supplied to the coil;
a plurality of rods connected to the movable members; and
a supporting member connecting ends of the rods.

[25] The actuator as claimed in claim 24, wherein both ends of the inner and outer permanent magnets are provided with first circular inner and outer supplementary permanent magnets and second circular inner and outer supplementary permanent magnets, respectively, and the movable member is integrated with the coil by providing first and second circular magnetic rings to both ends of the coil, respectively.

[26] The actuator as claimed in claim 25, wherein the inner and outer permanent magnets consist of a superconducting magnet.

[27] A circuit breaker comprising:
a plurality of electro-magnetic force driving actuating parts mounted in a body made of magnetic material; and
each of the actuating parts including:
circular inner and outer permanent magnets concentrically mounted to maintain a radial interval between the magnets;
a movable member having a circular coil, mounted to be linearly movable in an

axial direction between the inner and outer permanent magnets and linearly moving in the axial direction between the inner and outer permanent magnets with electromagnetic repulsive forces occurring due to magnetic fields by the inner and outer permanent magnets and a current density of the coil when current is supplied to the coil;

a plurality of rods connected to the movable members; and

a supporting member connecting ends of the rods,

an insulation-actuating rod connected to the supporting member in order to linearly move by the movable members and thus to perform closing and opening operations.

[28] The circuit breaker as claimed in claim 27, wherein both ends of the inner and outer permanent magnets are provided with first circular inner and outer supplementary permanent magnets and second circular inner and outer supplementary permanent magnets, respectively, and the movable member is integrated with the coil by providing first and second circular magnetic rings to both ends of the coil, respectively.

[29] The circuit breaker as claimed in claim 28, wherein the inner and outer permanent magnets consist of a superconducting magnet.